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"Net Neutrality," Non-Discrimination and Digital Distribution of Content Through the Internet*

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Abstract: The vast majority of U.S. residential consumers face a monopoly or duopoly in broadband Internet access. Until now, the Internet has been characterized by a regime of "net neutrality," which means there has been no discrimination between the price of transmitting packets based on the identity of either the transmitter or the identity of the receiver, based on the application, or the type of content the packet contains. Providers of DSL or cable modem Internet access in the United States are taking advantage of a recent regulatory change that effectively abolishes "net neutrality" and non-discrimination protections. Due to their market power, these service providers are considering a variety of discriminatory pricing schemes. This article discusses and evaluates the effect a number of these schemes would have on the prices and profitability of network access, as well as the effect on complementary application and content providers. This article also discusses an assortment of anti-competitive effects created by price discrimination and evaluates the possibility of "net neutrality" being imposed by law.

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I. INTRODUCTION

The Internet is a global, interconnected network of computers that allows data transfers and provides a variety of interactive, real-time and time-delayed telecommunications services. Internet communications are based on common, public protocols. Hundreds of millions of computers are connected to the Internet at any moment. The vast majority of computers connect to the Internet through commercial Internet Service Providers ("ISP"s).[1] Users connect to the Internet through ISP dial-ups, cable modems connections, residential Digital Subscriber Lines ("DSL"), or through corporate networks (Local Area Networks ("LAN"s)). Ninety-eight percent of domestic residential broadband customers access the Internet through DSL or a cable modem.[2] Only about half of residential consumers have a choice between even two providers. Typically, the routers and switches owned by the ISP send the caller's packets to a local Point of Presence ("POP") on the Internet. In dial-up, cable modem, and DSL, the access POPs, as well as corporate networks dedicated access circuits, connect to high-speed hubs. Generally, access POPs (which serve dial-up, cable modem and DSL connections) and corporate networks with dedicated access circuits connect to high-speed hubs. High-speed circuits, leased from or owned by telephone companies, connect the high-speed hubs, forming an Internet Backbone Network ("IBN").

The Internet is the primary global network for digital communications. A number of different services are provided on the Internet, including, among numerous others, e-mail servers, browser interfaces (using Internet Explorer, Firefox, Opera, or others), Peer-to-Peer file exchange services, and Internet telephony (Voice over Internet Protocol ("VOIP")). A number of software applications run on top of the Internet browser, including information services (Google, Yahoo, MSN), image displays, video transmissions and others. Since the advent of Mosaic, the first Internet browser, in 1993, the Internet has evolved beyond text-based interface to support images, sound, and video transmitted in digital format. Even full-length movies are regularly downloaded, rented, or sold through

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[1] Educational institutions and government departments are also connected to the Internet but do not offer commercial ISP services.

[2] See Senate Committee on Commerce, Science, and Transportation, *Hearing on "Network Neutrality"* (testimony of Vinton G. Cerf), 109th Cong., 1st sess., 2006, http://commerce.senate.gov/pdf/cerf-020706.pdf (accessed April 10, 2008).

commercial services over the Internet and viewed on personal computers or television sets.

As video services and the digital distribution of content over the Internet grow, Internet broadband access providers including AT&T, Verizon, and a number of cable TV companies, have recently demanded additional compensation for carrying digital services. Ed Whitacre, the Chief Executive Officer of AT&T, expressed his company's dislike of existing regulatory structures: "Now what they would like to do is use my pipes free, but I ain't going to let them do that because we have spent this capital and we have to have a return on it."[3]

The claim that consumers, content providers, or applications providers use the Internet for free is certainly incorrect.[4] Currently, users pay ISPs for access to the Internet. Similarly, ISPs pay fees to Internet backbones for access to the Internet.[5] ISPs pay per month for

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[3] "Online Extra: At SBC, It's All About 'Scale and Scope,'" *BusinessWeek*, November 7, 2005, http://www.businessweek.com/@@n34h*IUQu7KtOwgA/magazine/content/05_45/b3958092.htm (accessed April 10, 2008).

Interview of Ed Whitacre:

> Q. How concerned are you about Internet upstarts like Google (GOOG), MSN, Vonage, and others?
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> A. How do you think they're going to get to customers? Through a broadband pipe. Cable companies have them. We have them. Now what they would like to do is use my pipes free, but I ain't going to let them do that because we have spent this capital and we have to have a return on it. So there's going to have to be some mechanism for these people who use these pipes to pay for the portion they're using. Why should they be allowed to use my pipes?
> The Internet can't be free in that sense, because we and the cable companies have made an investment and for a Google or Yahoo! (YHOO) or Vonage or anybody to expect to use these pipes [for] free is nuts!

[4] Of course, the categories of consumers, content providers and applications providers intersect since a consumer could also be providing content to some extent. In making the distinction between these three categories of Internet participants I define them by their primary function.

[5] This service is called "transit." See Nicholas Economides, "The Economics of the Internet Backbone," in *Handbook of Telecommunications*, ed. S. Majumder, et al., 379–381 (New York, NY: Elsevier B.V. 2005), http://www.stern.nyu.edu/networks/Economides_ECONOMICS_OF_THE_INTERNET_BACKBONE.pdf (accessed April 10, 2008); Nicholas Economides, "The Economics of the Internet," in *The New Palgrave Dictionary of Economics* (forthcoming), http://www.stern.nyu.edu/networks/Economides_

a virtual "pipe" of a certain bandwidth, according to their expected use.[6] When digital content (or information packets of any service) is downloaded by consumer *A* from provider *B*, both *A* and *B* pay. *A* pays his ISP through his monthly subscription, and *B* pays similarly. In turn, ISPs pay their respective backbones through their monthly subscriptions. Unlike a traditional telephone call arrangement in which only the calling party pays, Internet backbones collect from both sides of a communication.

So, what change would AT&T's CEO like to see in the pricing and industry structure? He desires the abolition of "net neutrality," the regime that does not distinguish in terms of price between bits or information packets according to the services that they provide, and additionally fails to distinguish in price based on the identities of the uploader and downloader. This pricing regime has prevailed since the inception of the commercial Internet.[7] Presently, an information packet used for VOIPs, email, images, or video is priced equally as a part of the large number of packets that correspond to the subscription services of the originating and terminating ISPs.

In addition to content neutrality, there is no distinction made according to the identities of the uploader and downloader. AT&T, Verizon, and cable Internet access providers would like to abolish the regime of "net neutrality" and in its place substitute a pricing schedule that charges both the final customer for his or her basic transmission service and the transmission's originating party (such as Google, etc.) for the provision of content. An access network, for example AT&T, wants to charge fees to an originating party even when the originating party does not connect to the Internet using AT&T and therefore does not have any contractual relationship with AT&T. Access network operators have also reserved the right to charge differently based on the identity of the provider even for the same type of packets; for example, an ISP may charge Google more than Yahoo for the same transmission. The proposed Internet model, without "net neutrality," would more closely mirror the traditional pre-Internet

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Economics_of_the_Internet_for_Palgrave.pdf (accessed April 8, 2008). In addition to transit service, Internet backbones of comparable size "peer" with each other, which means that they agree not to exchange money for exchanged traffic.

[6] See Economides, *The Economics of the Internet Backbone*, Table 5.

[7] We disregard pricing issues in the pre-commercial Internet when it was first primarily a network among military contractors and later a network among primarily academic communities.

telecommunications model in which customers pay *per service*.[8] This would be a very sharp departure from the way the Internet was designed to operate and how it has run since its inception (that is, pricing without reference to particular services or functions of the transmitted information packets).

After the acquisition of AT&T by Southwestern Bell ("SBC")[9] and of Microwave Communications Inc. (MCI) by Verizon, enabled by a change in regulatory rules by the Federal Communications Commission, the resulting consolidated companies (AT&T and Verizon) now advocate price discrimination according to the type of application and the provider used to transmit the content.[10] AT&T, Verizon, and cable TV companies would like to abolish the regime of "net neutrality" and substitute a complex pricing schedule where, besides the basic charge for transmission of bits, there will also be additional charges by the Internet access operator applied to the originating party (such as Google, Yahoo, or MSN). These charges would apply even when the application provider is not directly connected to AT&T or Verizon, that is, even when Google's ISP is not AT&T or Verizon.[11]

The broadband Internet access providers' new pricing scheme will most likely impose price discrimination on the provider side of the market and not on the subscriber. That is, the change will implement two-sided pricing. This is uniquely possible for firms operating within a network structure. Outside of traditional networks, such two-sided pricing is also made possible by the intermediaries operating between trading parties in exchange networks (such as the exchanges themselves).[12] There is presently considerable debate over the

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[8] See Nicholas Economides, *Telecommunications Regulation: An Introduction*, in *The Limits and Complexity of Organizations,* ed. Richard R. Nelson, 48–76 (New York, NY: Russell Sage Foundation Press, 2005), http://www.stern.nyu.edu/networks/Economides_Telecommunications_Regulation.pdf (accessed April 10, 2008). A discussion of the differences between the Internet and earlier digital data networks, and an exposition of traditional telecommunications regulation.

[9] SBC changed its name to AT&T after it acquired AT&T.

[10] Recently, Deutsche Telecom and Telecom Italia have made similar proposals.

[11] See Economides, "Telecommunications Regulation: An Introduction." The proposed Internet model without "net neutrality" would be closer to the traditional pre-Internet telecommunications model where customers pay per service.

[12] See Nicholas Economides, "Competition Policy in Network Industries: An Introduction," in *The New Economy and Beyond: Past, Present and Future*, ed. Dennis Jansen, 112–13 (London: Edward Elgar, 2006), http://www.stern.nyu.edu/networks/Economides_

legality, as well as the efficiency, of the implementation of the proposed changes. There is additional concern due to the considerable market power of such firms.

II. ABOLITION OF NON-DISCRIMINATION REQUIREMENTS

Electronic networks are created by a number of different, complementary levels of necessary operation. The Internet is supported by low-level sets of protocols, primarily Transmission Control Protocol/Internet Protocol ("TCP/IP"). These protocols define three basic levels of functions in the network: (1) the hardware/electronics level of the physical network, (2) the (logical) network level where basic communication and interoperability is established, and (3) the applications/services level.[13] The Internet separates the network interoperability level from the applications/services level. This means that, unlike earlier centralized digital electronic communications networks, such as CompuServe, AT&T Mail, Prodigy, and early AOL, the Internet allows a large variety of applications and services to be run "at the edge" of the network and *not* centrally. This means that users have a tremendous amount of choice: if a user elects to download video, he can do so without asking permission from a central authority in the network. For example, if a user elects to run a spyware-stopper, he may do so according to his preference; the network does not select security software for him.

The tremendous degree of choice of applications and content on the Internet is a direct consequence of its design, in which intelligence, applications, services, and content live "at the edge" of the network and are only dependent on the network for connectivity. A key consequence of "net neutrality" pricing has been successful innovation resulting, for example, in Google, Yahoo, and MSN as well as the large number of applications developed by companies that do not own any network infrastructure. Many companies have been able to innovate at the edge of the network. These innovations include new

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Competition_Policy.pdf (accessed April 10, 2008), for a discussion of two-sided pricing in a network.

[13] See Richard S. Whitt, "A Horizontal Leap Forward: Formulating a New Communications Public Policy Framework Based on the Network Layers Model," *Federal Communications Law Journal* 56 (May 2004): 587–672; Senate Committee, *Hearing on "Network Neutrality."*

methods of content distribution (both news and entertainment),[14] the distribution and modification of applications (including patching and updates), and the creation of many new applications such as interactive advertising.

Since the beginning of the commercial Internet, Internet pricing did not discriminate with respect to the identity of those receiving information packets, those sending them, or the nature of the information packets and the function they served. The content of the packets and the frequency of interactions are all irrelevant. Networks simply set different prices according to the bandwidth required for transfers. Transmitters and receivers of Internet information packets are charged according to the amount of bandwidth they subscribe to. For example, a residential DSL customer may buy from his ISP a 384Kb per second bandwidth pipe, while a business customer can buy a multiple of the same. Similarly, ISPs are charged—by Internet backbones—subscription fees according to the bandwidth they require/use.

Typically, Internet transmissions are carried over infrastructure owned by telecommunications companies, cable TV companies, and terrestrial satellites. Following the regulatory tradition of the United States, until the summer of 2005, telecommunication-facility-based Internet transmissions were subject to common carrier regulation that included non-discrimination requirements. Other Internet transmissions, those not telecommunication-facility-based, were not subject to common carrier regulation. Thus, DSL service was considered a common carrier service, and therefore subject to non-discrimination provisions. Cable modem service, in contrast, was not considered common carrier service, and therefore did not have to abide by such provisions.

In the summer of 2005, the Federal Communications Commission changed the classification of Internet transmissions from "telecommunications services" to "information services."[15] This implied that there were no longer "non-discrimination" restrictions on Internet service pricing. The remarks of the president of SBC (now AT&T after SBC acquired AT&T in 2005–2006), and similar

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[14] There are significant changes in many industries because of the Internet. For example, dissemination of news through the Internet has cut radically into the circulation of newspapers and has resulted in a round of consolidations among newspapers.

[15] In mid-2005 the FCC reclassified Internet service to no longer be subject to non-discrimination rules. See *Nat'l Cable & Telecomm. Ass'n v. Brand X Internet Servs*, 125 S. Ct. 2688 (2005).

expressions by Verizon and cable TV companies, underscore the concerns of network infrastructure operators who are keen to extract more of the value generated by the information packets they transport. This value accrues to both final consumers as consumers' surplus[16] and to application or content providers as profits.

It is widely believed that an additional reason for the proposed change is the increasing introduction of video services by AT&T and Verizon. It is expected that video services will congest "last mile" broadband Internet access as it is presently sold. Therefore, AT&T and Verizon would like to set up pricing differentiation so that consumers will buy the content generated by their service provider rather than the content offered by the service provider's competitors. However, broadband access providers have not committed to any restriction on their ability to extract additional surplus from their consumers and content or application providers. In addition, broadband access providers have not committed to restrictions on the use of price discrimination instruments. Industry lobbyists have proposed congressional bills that legalize the ability of an access provider to impose *any* price discrimination scheme it chooses. Presently, residential consumers pay at most $24 billion a year for broadband Internet access, as shown in Section IV. The combination of the consumers' surplus and the profits generated by Internet-distributed complementary applications and Internet-distributed content are a very large multiple of the current cost of residential broadband service. Thus, changes in fee structure proposed by access providers have the potential to seriously disrupt the current distribution of wealth between content, applications, and transmission service providers.

To put the proposed change in perspective, it is useful to understand what unrestricted discriminatory pricing would mean in the context of a traditional telecommunications network. If a telephone company were free from legal restrictions on price discrimination the company could, for example, routinely charge more for phone calls between investment bankers. This additional charge may be "justified" by the company because such phone calls are more likely to generate value than the average phone call. If phone companies were unregulated with respect to price discrimination, they could charge more for fax telephone calls than for other calls, since fax transmissions are likely to be more valuable on average than phone calls. Similarly, a telephone company without a non-discrimination

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[16] Consumers' surplus is the difference between what consumers are willing to pay and what they actually pay.

requirement could charge a high price for 911 emergency calls because the willingness to pay for these calls is obviously high.

As discussed above, the Internet under the "net neutrality" model separated the network layer from the applications/services layer. This allowed firms to innovate "at the edge of the network" without seeking approval from network operators.[17] The decentralization of the Internet based on "net neutrality" facilitated innovation resulting in successes such as the creation of the World Wide Web, Google, MSN, Skype, Yahoo, etc. "Net neutrality" also increased competition among the applications and services that operate "at the edge of the network," which did not need to own a network in order to compete. The existence of network effects (the increase in value that each user experiences as more users are added to the network) on the Internet implies that efficient prices to users on both sides (consumers and applications) are lower than they would be in a market without network effects.[18] A departure from "net neutrality" is likely to increase prices, which will reduce network effects and hamper innovation.

III. DETAILED EXAMINATION OF ANTI-COMPETITIVE CONCERNS ARISING FROM THE ABOLITION OF "NET NEUTRALITY"

A. HORIZONTAL CONCERNS

The abolition of "net neutrality" raises both horizontal and vertical antitrust and public interest issues. In addition to the pricing issues, there are concerns that network operators will discriminate against certain types of content and political opinions.[19]

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[17] Vint Cerf, one of the "fathers of the Internet," has called this environment "innovation without permission" of the network. Senate Committee, *Hearing on "Network Neutrality,"* (testimony of Vinton G. Cerf).

[18] See Nicholas Economides, "The Economics of Networks," *International Journal of Industrial Organization* 14 (1996): 675–99, http://www.stern.nyu.edu/networks/Economides_Economics_of_Networks.pdf (accessed April 10, 2008).

[19] See, for example, House Committee on the Judiciary, *Hearing on "Network Neutrality: Competition, Innovation, and Nondiscriminatory Access*," 109th Cong., 2nd sess., 2006 (testimony of Tim Wu), at http://judiciary.house.gov/media/pdfs/wu042506.pdf (accessed April 10, 2008). Wu discusses how Western Union, in the 1860s, when it had a telegraph monopoly, wrote an exclusive contract with the Associated Press that discriminated in price against other news organizations, and that resulted in a near monopoly for the Associated Press.

This section starts with a discussion of the horizontal antitrust concerns. Carriers in the "last mile" to the home have significant market power. Residential retail customers may have difficulty changing ISPs in response to price or quality changes. For 98% of residential consumers in the United States, there are only one or two choices for broadband Internet access: either DSL or cable modem access.[20]

Cable TV broadband Internet service is available to 92% of U.S. households but market penetration is significantly lower.[21] Most cable TV companies offer broadband Internet access only in conjunction with a digital cable TV package.[22] Due to technical limitations, DSL is offered only to households that are close to a local telephone company switch; the capabilities of the connection diminish as the distance from the switch increases. The vast majority of U.S. households cannot buy DSL service (so-called "naked DSL") without at the same time subscribing to voice telephone service on the same line.[23] Even where naked DSL is available, its price often significantly exceeds the price of DSL service that includes voice provision on the same line.

Due to coverage and bundling issues, and the very limited number of residential broadband providers, existing providers, typically AT&T, Verizon, or a cable TV company, have significant market power. The complications of changing equipment, configuration, email addresses, etc., imply significant switching costs for customers. Such costs add to the market power of existing local access providers. Finally, residential customers are affected by bundling of broadband Internet access with other services, such as telecommunications and cable television. However, despite the significant market power and high concentration in the Internet broadband access market, carriers are unable to effectively discriminate in price between monopoly and

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[20] Senate Committee on Commerce, Science, and Transportation, *Hearing on "Network Neutrality,"* (testimony of Vinton G. Cerf).

[21] See National Cable and Telecommunications Association, http://www.ncta.com/Statistic/Statistic/ResidentialCableHighSpeedDataSubscribers.aspx (accessed April 10, 2008).

[22] Even when broadband Internet access is offered by itself, it is typically offered at the full price of the bundle of Internet access and digital cable TV combined.

[23] There is no technical requirement for this, and the EU has mandated unbundling of the fixed local telecommunications network that allows DSL to be provided separately from voice service, as well as in its absence.

duopoly customers. Marketing through mass channels constrains carriers by forcing them to set prices for large regions, typically covering multiple states. Some carriers have nationwide pricing. Thus, access carriers with significant market power are unable to extract value from consumers to an extent proportional with their market power.

Carriers have much less market power upstream on the Internet backbone because, despite some concentration, there is a much more egalitarian distribution of market share on the backbone than in the residential access market. Market share of national backbones are listed in Table 1 based on 1999 data and projections. In papers filed in support of the merger of SBC and AT&T, as well as the merger of Verizon with MCI, there was mention of two recent traffic studies by Ryan Hankin Kent Research ("RHK"). These studies, showing traffic for 2004, are summarized in Table 2. The data demonstrate a dramatic change in the ranking of the networks, with AT&T ranked first and MCI fourth in 2004. They also show that a much larger share of traffic (over 40%) is now carried by smaller networks. These latest traffic studies show that earlier concerns, expressed in the European Union ("EU") and by the United States Department of Justice, that the Internet backbone market would tilt to create monopoly situations, have proven overstated.[24]

Table 1. Market Shares of National Internet Backbones[25]

Company	1997	1999	2001 (projected in 1999)	2003 (projected in 1999)
MCI WorldCom	43%	38%	35%	32%
GTE-BBN	13%	15%	16%	17%
AT&T	12%	11%	14%	19%
Sprint	12%	9%	8%	7%
Cable &Wireless	9%	6%	6%	6%
All Other	11%	21%	22%	19%
Total	100%	100%	100%	100%

[24] See Economides, *Competition Policy in Network Industries* for a more detailed discussion of the EU and DOJ concerns regarding the WorldCom-MCI and MCI-Sprint mergers.

[25] Senate Committee on the Judiciary, *Hearing on the MCI WorldCom-Sprint Merger*, 106th Cong., 1st sess., 1999 27–38 (testimony of Tod A. Jacobs, Senior Telecommunications Analyst, Sanford C. Bernstein & Co., Inc.); Bernstein Research, MCI WorldCom (Bernstein Report, March 1999), 51.

Table 2. Carrier Traffic in Petabytes per Month in 2004[26]

Company	Traffic				Market share among all networks
	1Q2004	2Q2004	3Q2004	4Q2004	4Q2004
A (AT&T)	37.19	38.66	44.54	52.33	12.58%
B	36.48	36.50	41.41	51.31	12.33%
C	34.11	35.60	36.75	45.89	11.03%
D (MCI)	24.71	25.81	26.86	30.87	7.42%
E	18.04	18.89	21.08	25.46	6.12%
F	16.33	17.78	17.47	19.33	4.65%
G	16.67	15.04	14.93	15.19	3.65%
Total traffic Top 7 networks	183.53	188.28	203.04	240.38	57.78%
Total traffic all networks	313	313	353	416	100%

As shown in the above tables, concentration in the Internet backbone market is lower than in the broadband access market and has decreased in the last five years. Additionally, both firms and ISPs can connect with multiple suppliers. This practice, "multi-homing," is engaged in by many ISPs as well as many of their business customers for two reasons: first, ISPs and large business customers multi-home on various backbones to avoid outages; second, both ISPs and customers multi-home to place additional competitive pressure on their service providers. In contrast to the residential customer, who must often select among a small group of broadband access providers, business customers, especially large business customers, have many choices. The fact that the Internet access market is more competitive for large business customers is reflected in the significantly lower price per unit of bandwidth that large business customers pay, both in comparison to the prices residential customers pay and to the prices small business customers pay.

I first consider two-sided pricing by a monopolist who charges both final consumers and applications or content providers. I then

[26] Data from *RHK Traffic Analysis–Methodology and Results*, May 2005, as reported in Declaration of Marius Schwartz to the FCC in the SBC-AT&T merger. The identities of all networks are not provided, but it is likely that B, C, E and F are Level 3, Quest, Sprint, and SBC in unknown order.

discuss general price discrimination strategies by a monopolist. I follow up with the price discrimination issues in an oligopoly situation.

1. TWO-SIDED PRICING MODEL

I model the two-sided network as follows. Consider the strategic interactions between a network access monopolist A_0, an applications or content company B_1 (selling a complementary good to network access) and the final consumers of content when the network can charge a fee to both consumers and applications providers.[27] In the mathematical part of the text, for brevity I will be using the word "application" to mean both applications and content. The network access firm sells an Internet connection subscription to end users at price p_0. The application provider sells the application to end users at price p_1. The application provider also pays the network a per unit access fee s, which the network has set.

Assuming a linear demand structure, let the demand function of network access service be $q_0 = a_0 - b_0p_0 - dp_1$, and the demand of the application B_1 be $q_1 = a_1 - b_1p_1 - dp_0$.[28] In this model, the quantity intercept a_0 of the network access demand (representing actual sales when all prices are zero) depends on the inherent quality and function of the network and the variety (number) of applications that are transported on the network.[29] In the demand function, the parameter d measures the strength of the complementarity between the network and the application.[30,31] The profit function of the access network is

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[27] The mathematical structure of this model is similar to Nicholas Economides and Evangelos Katsamakas, *Two-sided Competition of Proprietary vs. Open Source Technology Platforms and the Implications for the Software Industry*, 52 MGMT. SCI. 1057, 1071 (2006), http://www.stern.nyu.edu/networks/Economides_Katsamakas_Two-sided.pdf.

[28] Ibid. This demand system can be generated by a population of users with differing willingness to pay. For example, it can be generated by a population of users of uniformly distributed types, each with a unit demand. This demand system can also be generated by a representative consumer with quadratic utility function.

[29] Ibid. The maximum sales of the network, a_0, may be larger than the maximum sales of the application, a_1, *i.e.*, $a_1 \leq a_0$.

[30] The degree of complementarity between two goods measures the extent to which two goods are used together.

[31] I assume $b_0, b_1 > d$, *i.e.*, that the own-price effect for each product dominates the cross-price effect. To create a benchmark, I assume zero cost.

$\pi_0 = \pi_{0u} + \pi_{0a}$, where $\pi_{0u} = p_0 q_0$ is the network profit from users, and $\pi_{0a} = sq_1$ is the network profit from the application access fees. The profit function of the application provider is $\pi_1 = (p_1 - s)q_1$.

I assume that network access firms and applications firms set prices in a two-stage game. In stage one, the access network sets the access fee *s* paid by the application provider. In stage two, the network access and the application provider set the price the end-user pays, p_o, p_1 simultaneously. We assume a non-cooperative game and we find and characterize the subgame-perfect Nash equilibria.

To find the non-cooperative equilibrium, we start the analysis at the last stage of the game. Imposing maximization conditions with respect to the choices of prices p_o and p_1 by the network and the application, we find the network and application prices as respectively increasing and decreasing functions of the network access fee *s*.[32] In the first stage of the game, the network chooses fee *s* anticipating second stage equilibrium prices. The necessary condition for profit maximization is $\frac{d\pi_0}{ds} = \left(p_0 \frac{dq_0}{ds} + q_0 \frac{dp_0}{ds}\right) + \left(s \frac{dq_1}{ds} + q_1\right) = 0$. A marginal increase of s affects both profit streams of the network firm. The network's profit from users increases by $p_0 \frac{dq_0}{ds}$ and decreases by $q_0 \left|\frac{dp_0}{ds}\right|$. The profit from the application firm increases by q_1 and decreases by $s \left|\frac{dq_1}{ds}\right|$.[33] The network's choice of s maximizes the sum of the two profit streams. The effect of s on the network profit from users is $\frac{d\pi_{0u}(s)}{ds} = d \frac{d\left(a_1\left(2b_0b_1 + d^2\right) - 6b_1\left(b_0b_1 - d^2\right)s\right) - 2a_0b_1\left(2b_0b_1 + d^2\right)}{\left(4b_0b_1 - d^2\right)^2}$. The profit from users is decreasing at $s = 0$, since $\frac{d\pi_{0u}(0)}{ds} = d \frac{a_1 d\left(2b_0b_1 + d^2\right) - 2a_0b_1\left(2b_0b_1 + d^2\right)}{\left(4b_0b_1 - d^2\right)^2} < 0$.

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[32] Specifically, equilibrium prices are $p_0 = \frac{2a_0b_1 - da_1 - 3db_1 s}{4b_0b_1 - d^2}$ and $p_1 = \frac{2a_1b_0 - da_0 + \left(2b_0b_1 + d^2\right)s}{4b_0b_1 - d^2}$.

Notice that $\frac{dp_1}{ds} > 0$ and $\frac{dp_0}{ds} < 0$, that is, as expected, the application price increases with the access fee s because the application firm faces a higher marginal cost, while the network price decreases as the application has a higher price. These two effects imply that sales of the access network (respectively application) increase (decrease) in the access fee *s*: $\frac{dq_0}{ds} = -b_0 \frac{dp_0}{ds} - d \frac{dp_1}{ds} > 0$ and $\frac{dq_1}{ds} = -b_1 \frac{dp_1}{ds} - d \frac{dp_0}{ds} < 0$.

[33] Both profit streams of the network are concave in *s* and, therefore, the total network profit is concave is *s*.

Therefore, the fee s_u^* that would maximize only the access network profit from users is negative.

The effect of fee *s* on the access network profit from the application is $\frac{d\pi_{0a}(s)}{ds} = b_1 \frac{2a_1b_0 - a_0d - 4(b_0b_1 - d^2)s}{4b_0b_1 - d^2}$. This profit is increasing at $s = 0$, if $2a_1b_0 - a_0d > 0$. Then s_a^* is positive, and therefore s^* may be positive or negative $(s_u^* < s^* < s_a^*)$. The access fee s^* is positive when, at *s* = 0, the access profit from the application is increasing at a faster rate than the profit from users is decreasing. Figure 1 shows an example of that case. Figure 2 shows the relationship between the network's fee to the application, the network profit, the application's profit and the total industry surplus, which is the sum of the profits of the network, the profits of the application, and consumers' surplus.

The two-stage game has a unique sub-game perfect Nash equilibrium given by the following prices:

$$s^* = \frac{a_1(8b_0^2b_1^2 + d^4) - a_0b_1d(8b_0b_1 + d^2)}{2b_1(b_0b_1 - d^2)(8b_0b_1 + d^2)},\ p_0^* = \frac{a_0b_1(8b_0b_1 + d^2) - a_1d(10b_0b_1 - d^2)}{2(b_0b_1 - d^2)(8b_0b_1 + d^2)},$$

$$p_1^* = \frac{a_1(12b_0^2b_1^2 - 2b_0b_1d^2 - d^4) - a_0b_1d(8b_0b_1 + d^2)}{2b_1(b_0b_1 - d^2)(8b_0b_1 + d^2)}.$$

Figure 1. Network Profit Streams and Access Fee, *s**

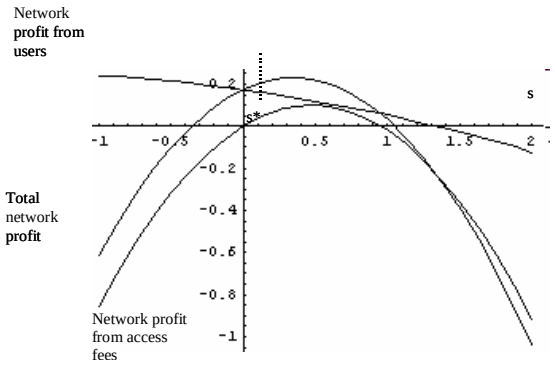
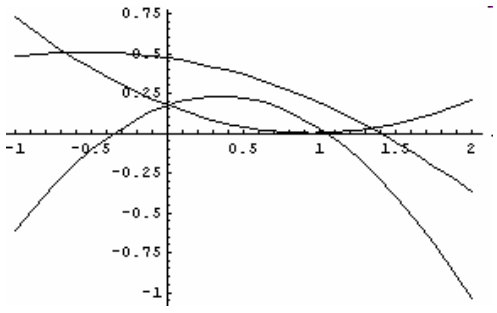


Figure 2. Network Profits, Application Profits, and Total Industry Surplus



Thus, as Figures 1 and 2 demonstrate, total industry surplus is lower when the access network charges a positive fee to applications, even though a positive fee will typically be part of the equilibrium. Intuitively, this can be explained as follows: the fee acts as a marginal tax on the application and therefore increases its marginal cost and the price that the application charges to final consumers. Due to the complementarity between the application and the network, increasing the price of the application also hurts network sales. Thus, imposing a fee on the application would have a larger negative impact on total industry surplus than imposing the same fee on the consumers and no fee on the application. The same argument can be made in terms of network effects. There are network effects between the application and the network. Therefore, if the network imposes a fee on the application it will result in some negative effect on the network provider. For this reason, imposing a fee on applications reduces total industry surplus.[34]

2. PRICE DISCRIMINATING MONOPOLIST

The Internet, as it exists today, supports large numbers of applications and services. There is wide range in the willingnesses to pay for each type of service, and there is wide dispersion in its distribution. There is no simple index or measure of capacity or bandwidth use of an application that is closely correlated to the willingness to pay for that application. For example, bandwidth use is high for some highly valued services, such as video on demand, but bandwidth use is very low for information services, such as search or bidding in auctions in real time, which are also highly valuable.

In the absence of legally required non-discrimination, Internet broadband access providers may attempt to capture the consumer surplus that remains after uniform pricing. There are two reasons for this attempt. First, even in an unconstrained monopoly situation, price discrimination, based on differences in the elasticity of demand, increases profits. Second, uniform regional pricing, discussed above, constrains carriers' profits to duopoly levels, below the level that could be achieved through price discrimination. When selling to residential customers, a last mile monopolist carrier typically has the incentive to reduce the capacity of "plain" broadband Internet access service so

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[34] Although the duopoly competition model for access with monopoly or duopoly applications had not yet been developed, there is no reason to believe that the main result on reduction of surplus by the imposition of fees on applications is going to be different.

that it can establish a "premium" service at a higher price as discussed below.

Suppose that information packets differ according to the willingness of end-users to pay for them. Let packet of type/function i be offered at price p_i and its demand be $D_i(p_i)$, $i = 1, \ldots, n$, under a price discrimination model. Alternatively, all packets could be sold at the same price p. Assuming that the cost of transmission is the same for all packets, in a price discriminating network the monopolist faces a cost, $C(\Sigma_i D_i(p_i))$, and its profits under discrimination (Π_d) are $\Pi_d = \Sigma_i p_i D_i(p_i) - C(\Sigma_i D_i(p_i))$. It is easy to show that maximization of the monopolist's profits implies $[p_i - C'(\Sigma_i D_i(p_i))]/p_i = 1/\varepsilon_i$, where ε_i is the elasticity of demand for packets of type i. Alternatively when all packets are sold at the same price, the monopolist maximizes profits under uniform pricing Π_u ("u" for uniform pricing) $\Pi_u = p[\Sigma_i D_i(p)] - C(\Sigma_i D_i(p))$. Maximization of uniform pricing profits implies $[p - C'(\Sigma_i D_i(p))]/p = [\Sigma_i D_i(p)]/[\Sigma_i D_i(p)\varepsilon_i]$, that is, in uniform pricing, the percentage of price to cost margin is a weighted average of the elasticities of demand for the various types of packages.

In general, the coordinated introduction of price discrimination schemes may reduce output. There is a general theorem in economics that price discrimination, which reduces total output, also reduces total surplus.[35] Thus, the first anti-competitive concern is that price discrimination may reduce output.

Two additional considerations reinforce this anti-competitive concern. First, most applications on the Internet exhibit network effects as described above. This means that the last transaction/sale/download is worth more to the consumer when sales of compatible applications are higher. For example, the Google search application is more valuable when Google has a larger audience. Using YouTube is more valuable when there are more subscribers to that web place. Additionally, more individual users decide to subscribe and to post on a web space when the web space has more subscribers. The existence of network effects implies that the efficient prices (total surplus maximizing prices) are below the perfectly competitive prices, that is, below marginal cost.[36] Broadband access

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[35] This is contingent on serving all markets under uniform pricing, which holds here since I am starting with all markets served under "net neutrality." See Marius Schwartz, "Third-Degree Price Discrimination and Output: Generalizing a Welfare Result," *American Economic Review* 80 (1990): 1259–62.

[36] See Nicholas Economides, "The Economics of Networks," *International Journal of Industrial Organization* 14 (1996); 675–99, http://www.stern.nyu.edu/networks/Economides_Economics_of_Networks.pdf.

providers are charging, at best, duopoly prices, which are typically considerably higher than perfectly competitive prices. Thus, increasing present market prices as an effect of price discrimination will increase price divergence from efficient prices.

Second, the fact that application and content providers will be charged instead of subscribers is likely to mask the true cost of Internet service to residential subscribers and create additional price distortion and surplus loss.[37]

3. OLIGOPOLY CONCERNS

There is an additional concern in duopoly. Because broadband access competition is duopolistic in many areas, the creation of a "premium" service and the accompanying reduction in bandwidth capacity of plain service required to create it is likely to be coordinated among network access providers. The coordinated reduction of capacity in "plain" service is reminiscent of cartel behavior, such as two competing airlines deciding in a coordinated way to reduce their capacity in economy class. Therefore, the introduction of coordinated price discrimination may have anti-competitive consequences. In particular, if there is sufficient evidence that the markets for "plain" and "premium" services are sufficiently different, the cartelization of "plain" service is likely to be a Sherman Act Section 1 violation.

B. VERTICAL CONCERNS

There is also a variety of potentially anti-competitive vertical activity that could result in Sherman Act Section 2 violations as discussed below.

First, a carrier may favor its own content or application over that of independent providers. VOIP provided over broadband Internet by companies without a network infrastructure, such as Vonage or EarthLink, competes with traditional circuit-switched service provided by AT&T and Verizon and with VOIP provided by cable TV operators. Independent VOIP could be subject to discrimination. Additionally, both AT&T and Verizon are gearing to distribute video,[38]

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[37] The generally more competitive market for large business customers will not shield them from the levies imposed by the access carriers.

[38] See Fred Dawson, "More Details on Verizon's Initial Video Launch," *xchange.com*, http://www.xchangemag.com/hotnews/59h231024228723.html (accessed April 10, 2008).

and could favor their video services over that of others. In the absence of non-discrimination rules, last mile carriers can leverage their market power in the Internet broadband access market to control/support their voice telecommunications market. This concern applies both to telecommunications companies who can degrade opponents VOIP service to protect their fixed line voice service and to cable companies who may degrade their opponents' VOIP service to protect their own VOIP service.

Similar concerns operate with regard to carriers' video services. It should be clear that, although active sabotage of a competitor's service is an obvious, and illegal, form of discrimination, network access providers do not need to use these tactics. To discriminate effectively against a VOIP competitor, it will be sufficient for the access provider to set a high fee for access to the "premium lane," which will effectively block profitable operation by the competitor whose operation in the "standard lane" has been degraded by the high allocation of bandwidth to the fast lane.[39]

Second, the anti-competitive concerns are hardly limited to the products and services currently provided by the firms with market power in the access market. Such carriers can also leverage market power in broadband access to the content or applications markets through contractual relationships. Two examples of this use of market power follow:

First, a carrier can contract with an Internet search engine (or other application, or video content provider) to put it in "premium" service, while searches using other search engines have considerable delays using "plain" service. In this setup, the "plain" service can be tweaked to be sufficiently slow so that consumers will choose to do almost all their searches with the search engine in "premium" service. By making a "take it or leave it" offer to the various search engines, the access carrier can extract a large part of the profits created by complementary goods, in this example, search engines. In effect, this type of strategy can determine who will be the successful search (or application, or content) company. It would give tremendous power to the network company without any obtrusiveness or the active sabotage of any individual company.

Second, in the same setup, a carrier can actively sabotage a search engine (or application, or content) company with similar results as above.

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[39] *See* Nicholas Economides, "The Incentive for Non-Price Discrimination by an Input Monopolist," *International Journal of Industrial Organization* 16, no. 3: (1998): 271–84, http://www.stern.nyu.edu/networks/The_Incentive_for_Non-Price_Discrimination.pdf.

1. CALIBRATION OF POTENTIAL WELFARE LOSSES

There are no published estimates of the elasticity of demand for various Internet applications. Thus, it is very hard to estimate the exact effect of the proposed price discrimination scheme. However, Goolsbee, using early data, estimates the elasticity of demand for broadband Internet access to be approximately $\varepsilon = 3$, at a price of $40 with marginal cost at $25,[40] *i.e.,* at a 60% markup over cost.[41] We may assume, that a new price discrimination scheme would precipitate a moderate increase in average price of at least 20%. This would imply a deadweight loss ("DWL") of at least 6% of the annual total Internet broadband access bill, using the standard approximate calculation $DWL = (\Delta P)(\Delta Q)/2 = \varepsilon(QP)(\Delta P/P)^2/2$, where $\Delta P/P$ is the proposed percentage price increase, here 20%, and ε is the elasticity of demand, here $\varepsilon = 3$. OECD puts the number of broadband subscriptions in the United States at almost 60 million.[42] This brings the annual revenue to networks from broadband access to $24 billion and the estimated direct welfare loss to residential consumers to roughly $144 million annually. Currently, there is no good estimate of the additional welfare loss to business customers.

The above estimate is a moderate lower bound on the surplus losses that may be generated by price discrimination by the access networks. In addition to the direct losses to consumers, the proposed price discrimination scheme will decrease consumer surplus in a variety of ways:

1. It will decrease consumers' applications, and content providers' surplus because it will imply a further divergence from efficient pricing in the presence of network effects;

2. It will foreclose on the margin potential entrants in complementary applications and content markets;

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[40] Austan Goolsbee, "The Value of Broadband and the Deadweight Loss of Taxing New Technology," *Contributions to Economic Analysis and Policy* 5, no.1 (2006): 13, http://journals.ohiolink.edu/ejc/pdf.cgi/Goolsbee_Austan.pdf?issn=15380645&issue=v05i0001&article=1505_tvobatdlotnt.

[41] Here marginal cost does not mean the cost of a single transmission. It rather means deployment of service to a customer.

[42] Organization for Economic Co-operation and Development, "OECD Broadband Statistics to December 2006," http://www.oecd.org/document/7/0,3343,en_2649_201185_38446855_1_1_1_1,00.htm.

3. It will decrease innovative activity of applications and content providers at the edge of the network; and

4. It will give the access providers the ability to choose which content and/or application will be successful removing the significant benefits of mix and match.

It is difficult to quantify the extent of these surplus losses. Noting, however, that the current cost of residential access is less than $24 billion, the profits of the complementary goods and services and applications plus consumers surplus from these are a large multiple of this amount.

2. POLICY IMPLICATIONS

The question posed to Congress is whether it should intervene now by imposing non-discrimination restrictions or if it should wait for antitrust suits to be filed and resolved. In my opinion, it is better to impose the non-discrimination restrictions by law because:

1. Suits take time and much damage can be done before they are resolved. The legal system is slow and lawsuits will not be resolved in "Internet time."

2. The abolition of "net neutrality" gives rise to a variety of anti-trust concerns, while each suit would typically deal with one issue. Thus, delays may be compounded by the need for each type of suit to be adjudicated.

3. The Internet is a key essential network for growth of the U.S. economy. The United States is already lagging behind 14 countries in Internet penetration, as seen in Figures 3 and 4 below. Figure 4 shows that a number of countries with higher broadband Internet penetration than the United States have lower population densities, so U.S. population density does not explain the low penetration.[43] Since the Internet is a key factor for future growth, high penetration is desirable and adding price discrimination is unlikely to help.

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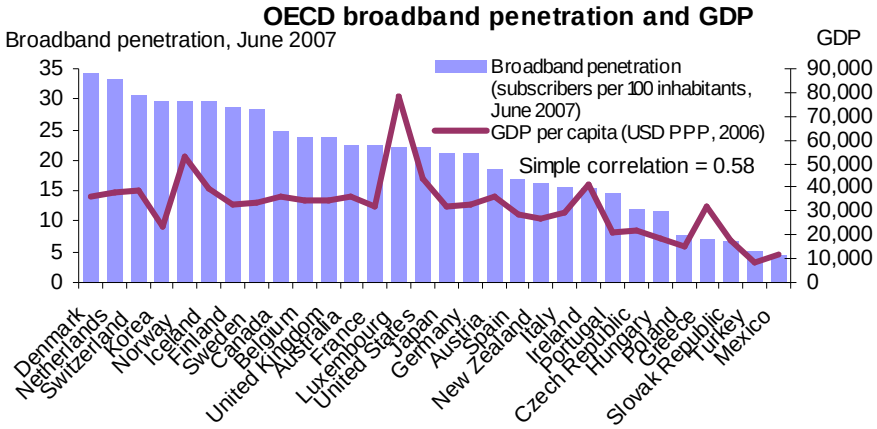
[43] Iceland, Finland, Norway, Canada and Sweden have lower population densities than the United States, but have significantly higher broadband Internet penetration.

4. Increasing prices through two-sided pricing will not increase network traffic or contribute to network growth.

5. The abolition of "net neutrality" is likely to have significant negative consequences on innovation on the Internet, whether or not anti-trust violations occur in connection with the abolition of "net neutrality", and therefore it is in the public interest to prevent it by law.

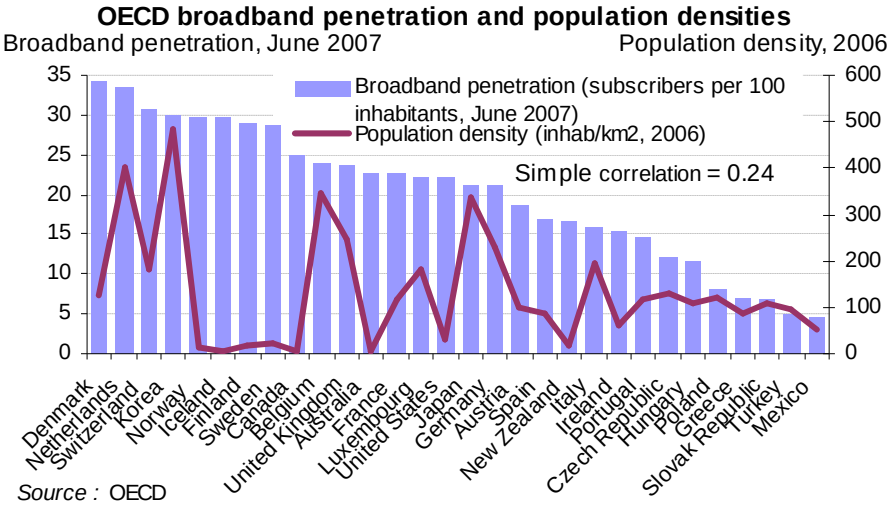
Figure 3. Broadband Internet Penetration and per Capita Income[44]



Source : OECD

[44] Organization for Economic Co-operation and Development, "OECD Broadband Statistics to December 2006," http://www.oecd.org/document/7/0,3343,en_2649_201185_38446855_1_1_1_1,00.html (accessed April 10, 2008).

Figure 4. Broadband Internet Penetration and Population Density[45]



IV. CONCLUSION

The Internet is the most important telecommunications network of the last fifty years. Enabled by public protocols and standards, and by significant advances in electronics, computers, fiberoptics, and laser technology, the Internet has been an engine for the growth of both the United States and world economies. Relying on public protocols, applications are developed to run across the Internet and content is disseminated on the Internet without the approval or consent of centralized Internet operators. Tremendous successes resulted such as the World Wide Web and all the applications that run on it, including big financial successes like Yahoo and Google, as well as big benefits of social interaction networks and great leaps in civil society through new discussion forums and formats.

The Internet, in its commercial form, is a relatively new network, with only a dozen or so years to date. Its tremendous acceptance and success has made it an essential part of both business and personal life. All previous electronic networks, including early successes, like AOL, have abandoned proprietary formats and folded into the Internet. The success of the Internet thus far has been based on openness and non-discrimination, which until recently, was

[45] Ibid.

guaranteed by U.S. telecommunications regulation. Recently, the abolition of this regulation has led to proposals by broadband Internet access providers that would radically change pricing on the Internet. This article shows that these changes are likely to hurt consumers and diminish innovative activities in complementary sectors such as computer applications and content dissemination. These pricing proposals, if implemented, are likely to raise a variety of significant anti-competitive concerns, outlined in detail in the article.

Among these concerns is the possibility that access providers will degrade and/or restrict capacity in traditional Internet access to force applications and content providers to use their new "premium" service. The possibility exists that this degradation and restriction of capacity will happen in a coordinated way, in a cartel-like fashion. This article demonstrates that, even in the absence of such discrimination, due to the existence of network effects, charging a fee to application and content providers is likely to both hurt consumers and to reduce the benefit that the Internet brings to society as a whole.

In addition, there are a large number of vertical anti-competitive concerns created by the absence of a non-discrimination policy. Access networks, if left unrestrained by non-discrimination rules, have incentives to favor their own services, applications, and content and to kill competing services, such as independent VOIP providers, which provide alternative telephone services over the Internet. Additionally, the access networks have incentives to leverage their access monopoly or duopoly market power in many other complementary markets by offering "take it or leave it" contracts. Thus, the access providers will be able to determine who will be the primary provider of search engines, content, and other applications and services. This would be highly detrimental to the consumers and industries that rely on the Internet.

The present question before Congress is whether to allow the Internet to be run without non-discrimination rules or whether to impose specific non-discrimination rules. A number of considerations favor imposing a specific rule supporting "net neutrality." First, litigation is very slow, and much damage can be done before the resolution of litigation establishes a clear rule. Second, there are a number of different antitrust concerns, and litigation will have to deal with each one at a time. Third, although the Internet is a crucial network supporting United States' economic growth, Internet penetration in the United States is low compared to many other countries with much lower per capita income. The imposition of discrimination is likely to amplify these problems. Fourth, because of network effects, the correct public policy is to subsidize the Internet, rather than increase its price. The price discrimination schemes

discussed are likely to effectively increase the price consumers pay for Internet access. Finally, the innovation "at the edge" of the network that has flourished under the regime of "net neutrality" would be significantly threatened by discriminatory actions.